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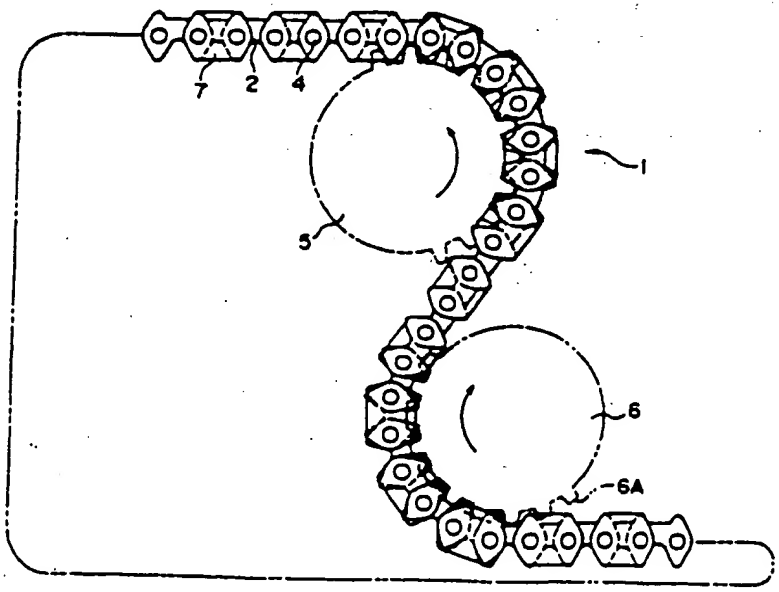
(54) Abstract Title
A Both-side meshing type silent chain

(57) A both-side meshing type silent chain 1 having a plurality of articular train plates 2 and guide train plates (3, fig 3) alternately connected together with pins 4, the plates 2 and (3, fig 3) being formed with main teeth (t, fig 3) on a front side for engagement with a sprocket 5 located on the inner side of the chain 1; guide plates 7 are disposed on the outer sides of the chain with the inside faces of the guide plates 7 arranged to come into abutment with side faces of the teeth of the sprocket 5 the rear sides of some of the articular and guide train plates 2 and (3, fig 3) are formed with sub-teeth (t', fig 3) for engagement with teeth of a sprocket 6 located on the outer side of the chain, and the rear sides of the guide plates 7 and remaining articular and guide train plates being formed as flat sections.

FIG.1



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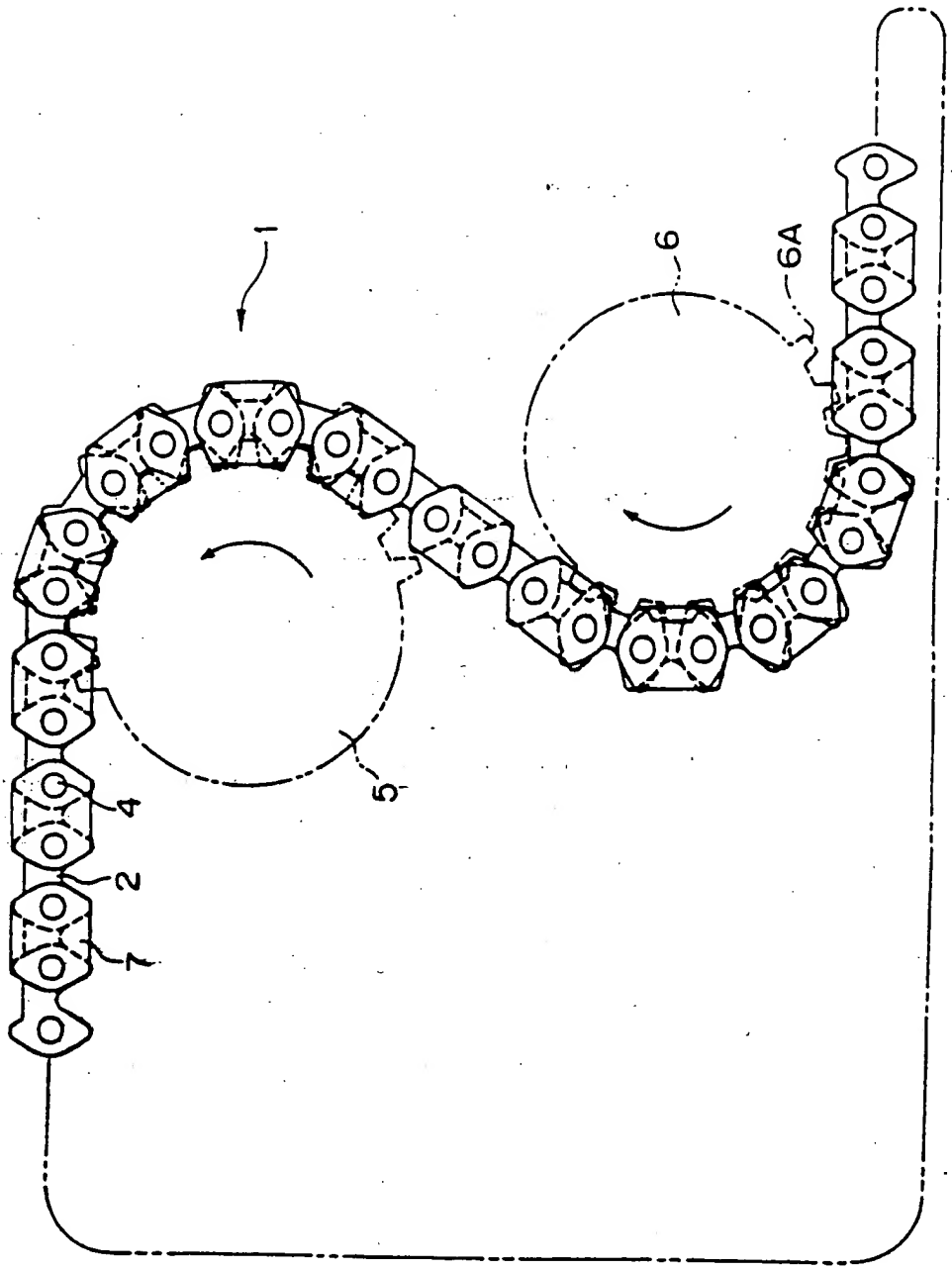


FIG.1

FIG.2

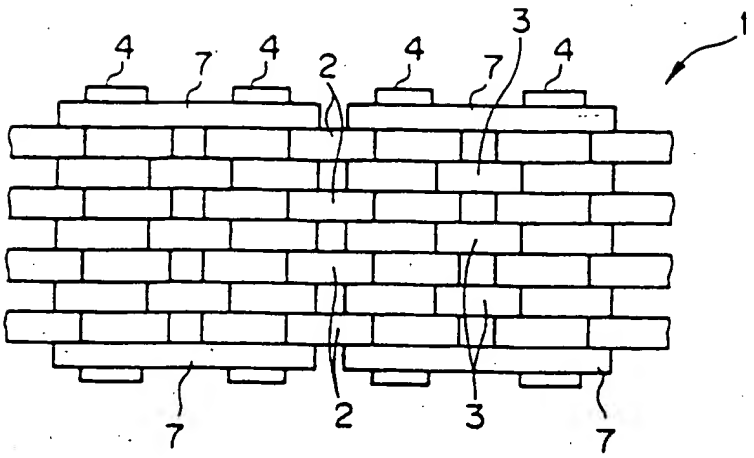


FIG.3

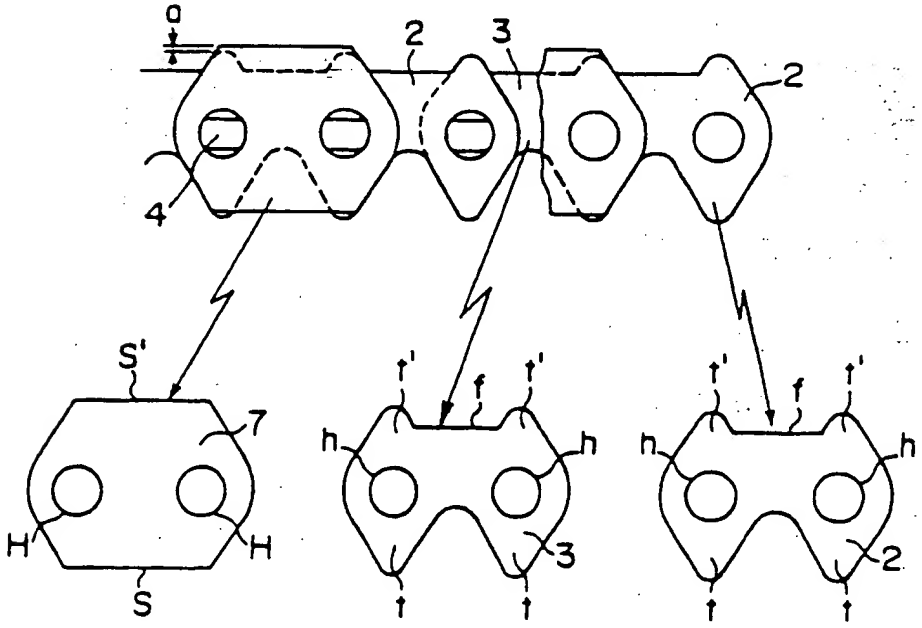


FIG.4

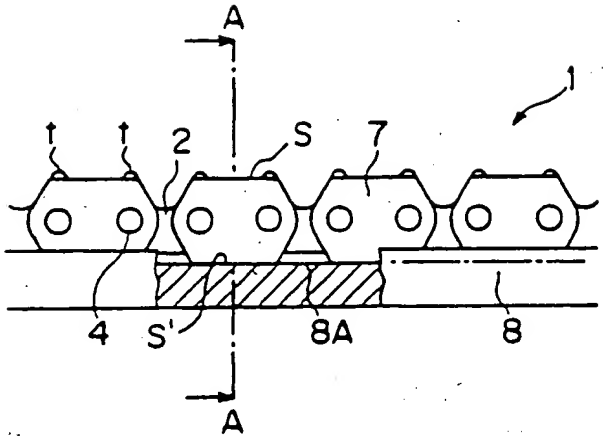


FIG.5

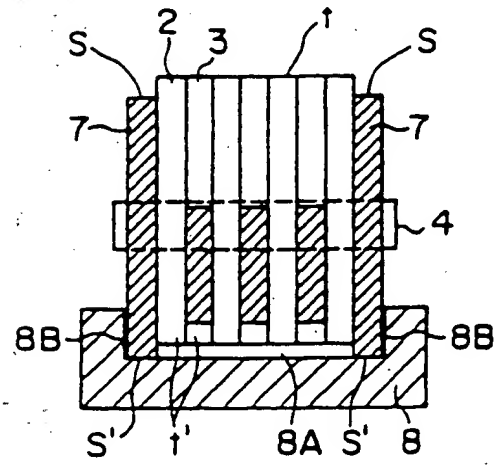


FIG.6

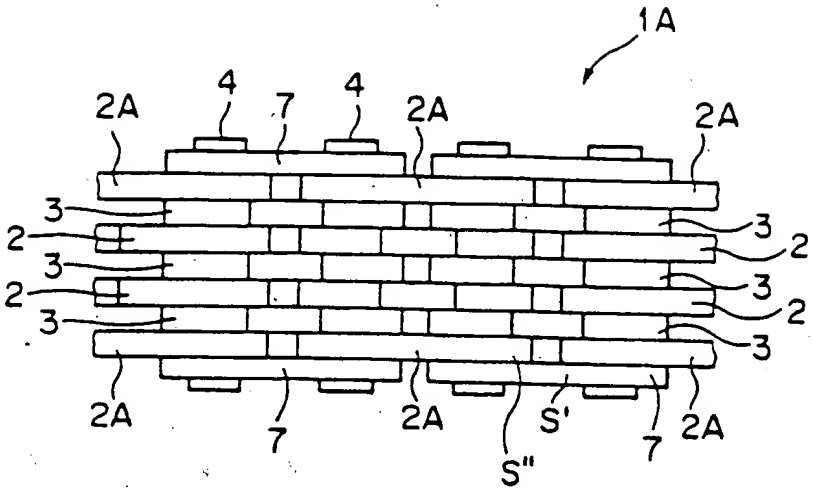


FIG.7

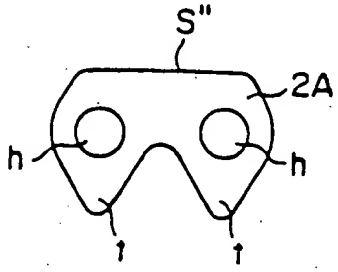


FIG.8

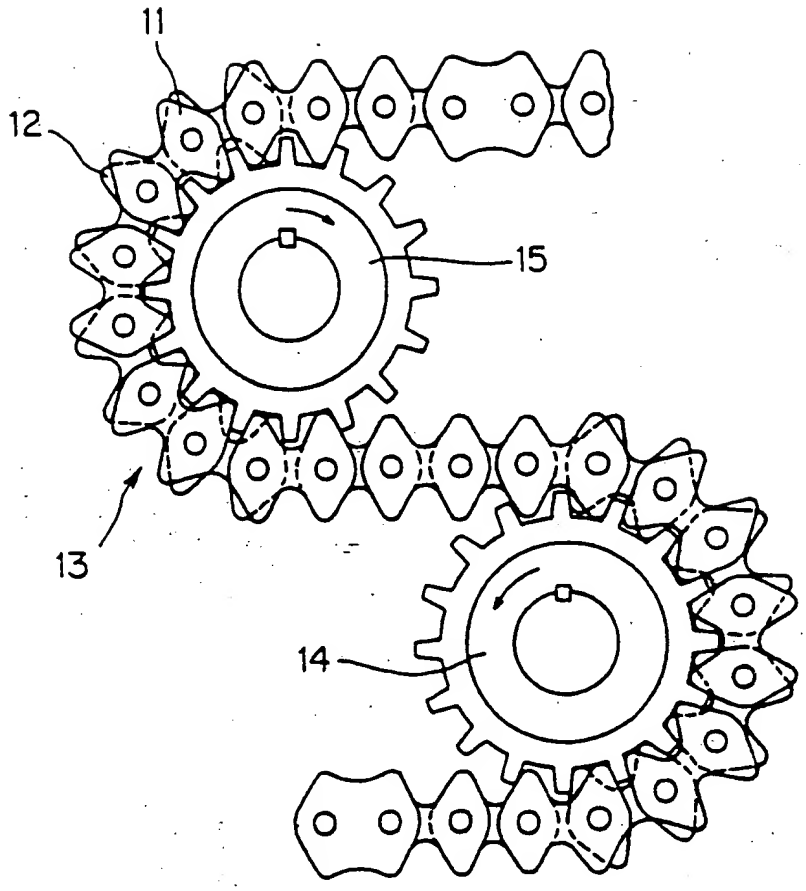
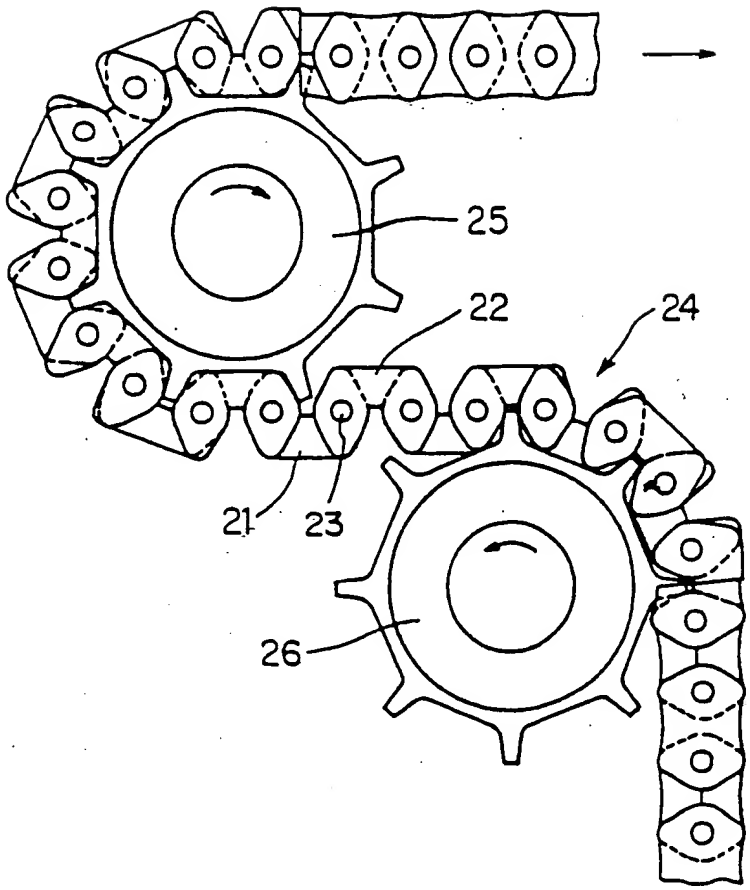


FIG.9



BOTH-SIDE MESHING TYPE SILENT CHAIN

The present invention relates to a so-called both-side meshing type silent chain capable of being engaged with sprockets on both inner and out periphery sides of the chain.

As a conventional both-side meshing type silent chain capable of meshing with sprockets on both inner periphery side ("front side" hereinafter) and outer periphery side ("rear side" hereinafter) of the chain through a large number of plates connected together in an endless manner, there is known, for example, such a silent chain as shown in FIG. 8. This silent chain 13 is assembled by connecting plates 11 and 12 in an endless fashion. It has teeth for engagement with a sprocket 14 located on an inner or outer periphery side of the chain 13 and also has teeth for engagement with a sprocket 15 located on the opposite side. The plates 11 and 12 are centrally constricted and a pair of chevron-shaped teeth are formed on both sides of each plate.

FIG. 9 shows another example of a conventional both-side meshing type silent chain. This silent chain 24 is assembled in an endless manner. More particularly, plates 21 each having a pair of chevron-shaped teeth on the front side and being flat, i.e., straight, on the rear side and plates 22 each being flat on the front side and having a pair of chevron-shaped teeth on the rear side are alternately connected together with pins 23 to constitute the chain 24. There are disposed a sprocket 25 meshing with one of inner and outer periphery sides of the silent chain 24, and a sprocket 26 meshing with the other side. The sprockets 25 and 26 are each formed with teeth at two-pitch intervals, with which the teeth of the plates 21 and 22 come into engagement.

If any of the above conventional silent chains capable of meshing with sprockets on both inner and outer periphery sides of the chain is used as a timing chain for an

automobile engine for example, it becomes possible to bring a sprocket into engagement with the outer periphery on a tension side of a chain circulation path and thereby draw the tension-side path as close as possible to a return-side path of the chain, whereby the space occupied by the entire chain circulation path can be diminished. However, since chevron-shaped teeth for engagement with sprocket teeth are formed on the rear side of the plate, it is difficult to bring the shoe faces of a tensioner and a chain guide into sliding contact with the rear face of the plate.

In more particular terms, if chevron-shaped teeth are formed on the rear side of plate, the plate teeth tips come into contact with the shoe faces intermittently, so that the shoe faces are worn out markedly, leading to shortening of their service life, or the vibration preventing effect is decreased by the intermittent contact, thus causing wear elongation of the chain and leading to generation of noise.

In such a both-side meshing type silent chain as shown in FIG. 9, which chain comes into mesh with sprocket teeth at two-pitch intervals, the amplitude of a polygonal motion upon such engagement of the two is large and hence it is impossible to perform a smooth and high-speed transmission of power. The problem of an early-stage wear of sprocket also results.

It is therefore an object of the present invention to solve the abovementioned problems of the prior art and provide a both-side meshing type silent chain which permits improvement in the service life of the shoes of a tensioner and a chain guide, which also permits a high-speed and smooth transmission of power, and which possesses a high durability.

According to the present invention, in order to achieve the abovementioned object, there is provided a both-side meshing type silent chain in which a plurality of articular train plates and a plurality of guide train plates are alternately connected together with pins, the articular train plates and the guide train plates each

being formed on a front side thereof with main teeth for engagement with teeth of a sprocket located, in use, on an inner periphery side of the chain; guide plates are disposed on both outer sides of the plural guide train plates, inside faces of the guide plates being arranged to come into abutment with side faces of the teeth of the sprocket located, in use, on the inner periphery side of the chain and being guided thereby; the rear sides of the plates which constitute at least some of the plural trains of the articular train plates and guide train plates are formed with sub-teeth for engagement with teeth of a sprocket located, in use, on an outer periphery side of the chain, while the rear sides of the remaining trains of plates and the rear sides of the guide plates are formed as flat portions which lie substantially in the same plane as the rear sides of the adjacent plates longitudinally of the chain in a stretched state of the chain.

Preferably, the rear sides of only the articular train plates adjacent to the guide plates are formed as flat portions which lie substantially in the same plane as the rear sides of the guide plates in a stretched state of the chain.

In the chain of the present invention, the main teeth formed on both articular train plates and guide train plates come into engagement with the sprocket located on the inner periphery side of the chain to effect the same transfer of power as in the ordinary type of silent chain. In this case, the inside faces of the guide plates disposed on both outer sides of the guide train plates come into abutment against side faces of the teeth of the inner periphery-side sprocket and are guided thereby, so that a transverse displacement of the chain is prevented.

On the other hand, the sub-teeth formed on the rear sides of plates which constitute at least some of the trains of the articular train plates and the guide train plates arranged in the longitudinal direction of the chain come into engagement with the sprocket located on the outer

periphery side of the chain, whereby the transfer of power is performed.

The rear sides formed as flat portions of at least the guide plates are brought into sliding contact with the shoe faces of a tensioner and a chain guide to prevent vibration of the chain. Where the chain has not only the guide plates but also another train of plates having rear sides formed as flat portions, the rear sides of those plates may also be brought into sliding contact with the shoe faces of the tensioner and the chain guide and be guided thereby.

Particularly, where the rear sides of only the articular train plates adjacent to the guide plates are formed as flat portions which lie substantially in the same plane as the rear faces of the guide plates in a stretched state of the chain, the rear sides of the guide plates and those of the articular train plates adjacent to the guide plates come into sliding contact in a symmetric manner with the shoe faces of a tensioner and a chain guide, so that the chain can be allowed to travel in a smooth and stable condition.

In the accompanying drawings:

FIG. 1 is a schematic view of a both-side meshing type silent chain according to an embodiment of the present invention;

FIG. 2 is a partial view thereof as seen from an outer periphery side of the chain;

FIG. 3 is a diagram showing shapes of various plates which constitute the silent chain;

FIG. 4 is a diagram showing a state in which the silent chain is in sliding contact with the shoe face of a chain guide disposed on the outer periphery side of the chain;

FIG. 5 is a sectional view as seen in the arrowed direction A-A in FIG. 4;

FIG. 6 is a partial view of a both-side meshing type silent chain according to another embodiment of the present

invention as seen from an outer periphery side of the chain;

FIG. 7 is a diagram showing the shape of an articular train plate adjacent to a guide plate;

FIG. 8 is a schematic view showing an example of a conventional both-side meshing type silent chain; and

FIG. 9 is a schematic view showing another example of a conventional both-side meshing type silent chain.

As seen in Figs 1 and 2, the chain 1 is assembled by connecting a large number of articular train plates 2 and guide train plates 3 alternately with pins 4 in an endless manner, and is shown travelling circulatively while meshing with a sprocket 5 disposed on an inner periphery side of the chain 1 and with a sprocket 6 disposed on an outer periphery side of the chain. The engagement of the sprocket (or sprockets) with the inner periphery side of the chain normally provides the primary traction.

The articular train plates 2 and the guide train plates 3 are each disposed transversely in a plural number, and guide plates 7 are disposed on both outer sides of such plural guide train plates 3.

FIG. 3 is a diagram showing the shape of each constituent plate of the chain 1. As shown in the same figure, the articular train plates 2 and the guide train plates 3 are of the same shape, with two pin holes for insertion therein of the pins 4 formed in each plate. On the front side of each of the plates 2 and 3 are formed a pair of main teeth t in a bifurcated, chevron, shape, which main teeth come into engagement with the sprocket 5 located on the inner periphery side of the chain 1. On the rear side of each of the plates 2 and 3 are formed a pair of sub-teeth t' for engagement with the sprocket 6 located on the outer periphery side of the chain.

Between the bottoms of the paired sub-teeth t' is formed a flat, i.e., straight, edge portion f, not so bifurcated shape as the main teeth t in order to avoid a decrease in sectional shape at the middle position between

the plates 2 and 3 which decrease in sectional shape would cause a lowering of strength.

The guide plates 7 are each formed with two pin holes H to be fitted on pins 4 at the ends of the pins. The front and rear sides of each guide plate 7 are formed as flat, i.e., straight edge portions S and S′ respectively.

As shown in FIG. 3, the flat portion S′ which forms the rear side of each guide plate 7 projects outward by a slight distance "a" with respect to the sub-teeth t′ of each of the articular train plates 2 and guide train plates 3.

The shape of the main teeth t is the same as those of an ordinary type of silent chain, and as the sprocket 5 shown in FIG. 1 there may be used a sprocket of a standard tooth shape. As to the sprocket 6 meshing with the sub-teeth t′, it is shallow in tooth bottom and its tooth tip 6A is formed as an arcuate surface concentric with the rotational center of the sprocket 6 in order that the flat portion f can be abutted against and supported by such arcuate tooth tip 6A at the time of engagement of the chain with the sprocket.

FIG. 4 illustrates a state in which the chain 1 travels in sliding contact with a shoe face 8A of a chain guide 8 disposed on the outer periphery side of the chain. The flat face S′ of each guide plate 7 slides on the shoe face 8A of the chain guide 8 and is thereby guided during its travelling.

In this case, since the tips of the sub-teeth t′ of the articular train plates 2 and the guide train plates 3 are slightly spaced from the shoe face 8A by means of the guide plates 7, there is no fear of abutment of the sub-teeth t′ with the shoe face 8A which would accelerate the wear thereof, nor is there any fear of vibration or noise of the chain 1.

If the chain guide 8 is provided on both right and left sides thereof with such vertical guide faces 8B as shown in FIG. 5, a transverse displacement of both outer

side faces of each guide plate 7 is restricted to prevent meandering of the chain 1.

FIG. 6 is a partial view of a both-side meshing type silent chain according to another embodiment of the present invention, as seen from an outer periphery side of the chain. In the same figure, as to all of guide train plates, part of articular train plates, pins and guide plates, which constitute the chain indicated at 1A, they are identical with those used in the previous embodiment and are therefore represented by the same reference numerals as in FIGS. 1 to 5.

In the chain 1A, a pair of articular train plates 2A adjacent respectively to the inside faces of guide plates 7 disposed on both sides are different in shape from articular train plates 2 located between the paired articular train plates 2A. The rear face of each plate 2A is formed as a flat edge portion S", as shown in PIG. 7. On the front side of each plate 2A, like the articular train plates 2, a pair of main teeth t are formed in a bifurcated shape, and two pin holes, h, are also formed.

The flat portion S" as the rear face of each articular train plate 2A and the flat face S' as the rear face of each guide plate 7 are formed so as to lie substantially in the same plane in a stretched state of the chain 1A.

Therefore, both flat portions S' and S" which respectively constitute the rear sides of each guide plate 7 and each articular train plate 2A come into sliding contact alternately with the shoe faces of the chain guide and tensioner disposed on the outer periphery side of the chain 1A. Besides, in the longitudinal direction of the chain 1A, the guide plate 7 and the articular train plate 2A partially overlap each other in the vicinity of pins 4, so that at the incoming position of the chain 1A relative to the shoe face the contact between the shoe face and the chain 1A becomes continuous, whereby the wear of the shoe face and the vibration and noise of the chain 1A can be

further diminished in comparison with the chain of the previous embodiment.

Although in this embodiment the rear side of only the articular train plate 2A adjacent to the inside face of each guide plate 7 is formed as the flat portion S", the rear side of the guide train plate 3 further adjacent to the inside face of the plate 2A may be formed as a flat portion to increase the contact area with the shoe face.

Moreover, a modification may be made if only the rear sides of the plates which constitute at least some of the trains of articular train plates 2 and guide train plates 3 are formed with sub-teeth for engagement with the teeth of the sprocket located on the outer periphery side of the chain and insofar as the rear sides of the remaining train of plates and those of the guide plates 7 are formed as flat portions which substantially lie in the same plane as the rear sides of the plates adjacent to each other longitudinally of the chain in a stretched state of the chain.

Further, although in the above embodiments the flat portion S' and S" which constitute the rear sides of the guide plates 7 and the articular train plates 2A, respectively, project slightly outwards with respect to the sub-teeth t' of the articular train plates 2 and guide train plates 3, this relation may be reversed, that is, the sub-teeth t' may project outwards with respect to the flat portions S' and S". This can be done by adopting a cross sectional shape having a difference in height so that the shoe faces of the tensioner and chain guide come into sliding contact with only the flat portions S' and S" and not with the sub-teeth t'.

According to the both-side meshing type silent chain of the present invention, as set forth above, the rear sides of plates which constitute at least some of the trains of articular train plates and guide train plates arranged in the longitudinal direction of the chain are formed with sub-teeth for engagement with the teeth of the

sprocket located on the outer periphery side of the chain, while the rear sides of the remaining train of plates and those of the guide plates are formed as flat portions which lie substantially in the same plane as the rear sides of the plates adjacent to each other longitudinally of the chain in a stretched state of the chain. Therefore, by bringing the rear sides formed as flat portions of at least the guide plates into sliding contact with the shoe faces of a tensioner and a chain guide, it is made possible to prevent vibration of the chain.

As a result, the chain slides smoothly in a state of face contact with the shoe face and hence not only the wear of the shoe face can be diminished but also the vibration of the chain caused by the sliding contact with the shoe face can be diminished. Consequently, the noise of the chain during operation of the chain can be suppressed, and the wear elongation of the chain is reduced, thereby permitting prolongation of the service life of the chain.

Moreover, no matter with which of the sprocket located on the inner periphery side of the chain and the sprocket located on the outer periphery side of the chain the chain may come into engagement, the chain engages the sprocket teeth securely pitch by pitch, so that the amplitude of a polygonal motion upon engagement of the chain with the sprocket becomes small, thus making it possible to perform the transmission of power at high speed, smoothly and highly efficiently.

Further, in the case where the rear sides of only the articular train plates adjacent to the guide plates are formed as flat portions positioned substantially in the same plane as the rear sides of the guide plates, the chain can be allowed to travel more smoothly and stably, whereby the wear of the shoe face and the generation of noise during operation of the chain can be diminished to a greater extent and the durability of the chain can be further enhanced.

Additionally, since the chain can be used as a timing chain for an engine with the shoe faces of a tensioner and a chain guide in abutment against the outer periphery side of the chain, it is possible to bring an idle sprocket into engagement with the outer periphery on a tension side of a chain circulation path and thereby draw the tension-side chain path as close as possible to a return-side chain path. Consequently, not only the space occupied by the whole circulation path can be reduced, but also by engaging a sprocket with the chain from the outer periphery side of the chain it is possible to drive an auxiliary machine such as an oil pump which rotates reversely to the driving shaft.

CLAIMS

1. A both-side meshing type silent chain in which a plurality of articular train plates and a plurality of guide train plates are alternately connected together with pins, the articular train plates and the guide train plates each being formed on a front side thereof with main teeth for engagement with teeth of a sprocket located, in use, on an inner periphery side of the chain; guide plates are disposed on both outer sides of the plural guide train plates, inside faces of the guide plates being arranged to come into abutment with side faces of the teeth of the sprocket located, in use, on the inner periphery side of the chain and being guided thereby; the rear sides of the plates which constitute at least some of the plural trains of the articular train plates and guide train plates are formed with sub-teeth for engagement with teeth of a sprocket located, in use, on an outer periphery side of the chain, while the rear sides of the remaining trains of plates and the rear sides of the guide plates are formed as flat portions which lie substantially in the same plane as the rear sides of the adjacent plates longitudinally of the chain in a stretched state of the chain.

2. A chain according to claim 1, wherein the rear sides of only the articular train plates adjacent to the guide plates are formed with flat portions which lie substantially in the same plane as the rear sides of the guide plates in a stretched state of the chain.

3. A chain, substantially as described with reference to Figs. 1 to 7 of the accompanying drawings.

The Patent Office

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Application No:	GB 9803999.3	**Examiner:**	Jason Clee
Claims searched:	1-3	**Date of search:**	12 October 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): F2Q: Q30-41

Int Cl (Ed.6): F16G 13/04

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	EP 0487146 A	(Multinorm B. V.) especially see fig 4	-
A	EP 0178818 A	(Borg-Warner Corporation)	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.